Industrial 3-year PhD Thesis - CIFRE grant

Analysis of the robustness of vehicle aerodynamics with respect to variations in wheel-related components

AMPERE SAS – Renault Group (Guyancourt, France)

Laboratory of Fluid Mechanics and Acoustics
CNRS, Ecole Centrale de Lyon, University of Lyon (Ecully France)

Pprime Institute
CNRS, University of Poitiers, ISAE-ENSMA (Poitiers, France)

Research program:

An in-depth understanding of how wheel components affect the overall aerodynamics of electric vehicles is crucial to enhance energy efficiency; wheels contribute to 10% to 20% of the overall drag. Wheel is used here as a generic term that corresponds to numerous combinations of tyres and rims having various effects on the drag of a vehicle. The specific design of electric vehicles opens up new possibilities for optimization if local losses due to wheels and their interactions with the flow at the scale of the vehicle are understood.

The PhD candidate will first familiarize himself / herself with the phenomenology of flows around automotive vehicles, and the various contributions to the aerodynamic drag. High-fidelity numerical simulations will be carried out on modeled configurations of increasing geometrical complexity by using a Lattice Boltzmann solver. At the scale of the wheels and of the vehicle, these simulations will aim at identifying, quantifying and describing (in terms of mass or momentum transfer and kinetic energy budget) the turbulent aerodynamic mechanisms linked to the wheels and having an impact the vehicle's overall drag.

The PhD candidate will assist in planning and completing measurement campaigns in the S2A automotive wind tunnel by using both mockups and selected real-size vehicles. The obtained experimental data will be supplemented by twin Lattice Boltzmann simulations. The primary objective will be to enhance the robustness and validation of the aerodynamic mechanisms, and to provide a comprehensive view of the influence of wheels on a vehicle's drag.

Context:

The PhD student will be immersed in a team of engineers at Renault's Guyancourt Technocentre for the two central years of the thesis, and will also benefit from the academic supervision of experts in computational fluid dynamics and vehicle aerodynamics in LMFA and PPRIME laboratories. The first and last semesters of the thesis will be spent at LMFA in Lyon.

Bibliographical references:

"Salient features of wheel-vehicle aerodynamic interactions: consequences for drag."
Bao, D., Borée, J., Sicot, C. and Roebroeck, C.
J. Wind Eng. Ind. Aerodyn. **236** 2023 https://doi.org/10.1016/j.jweia.2023.105366

"On the use of kinetic energy balance for the volumetric identification of drag sources of a blunt body. Application to road vehicles"
G. Bonnavion, J. Borée, V. Herbert
International Journal of Heat and Fluid Flow **96**, 2022

"Unsteady Lattice Boltzmann simulations of corner separation in a compressor cascade"
J. Boudet, E. Lévêque, H. Touil
Journal of Turbomachinery **144** (1), 2022

Requested skills:
Master or Engineer degree in Applied Physics or Applied Mathematics with a strong interest in Computational Fluid Dynamics. A marked taste for modeling and physical analysis in applied aerodynamics and turbulent fluid dynamics will be an asset.

Location:
Ampere SAS – Renault Group (Guyancourt, Renault Technocentre)
Laboratory of Fluid Mechanics and Acoustics (LMFA, Ecole Centrale de Lyon, Ecully)

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In addition, you can send us (see contacts) a Curriculum-Vitae, an application letter and your transcripts.

Please feel free to contact us for further information.